# A USER'S GUIDE TO THE MERCURY EMISSIONS MODEL

## REVISED MODEL

## FINAL REPORT

*Post-OMB Review*

Office of Solid Waste
U.S. Environmental Protection Agency

March 31, 1998

# ACKNOWLEDGMENTS

The Agency recognizes ICF Incorporated for the overall organization and development of this guide. ICF developed the database and analytical model that allowed for the comprehensive options analyses detailed in this guide. Lyn D. Luben, Gary L. Ballard, and W. Barnes Johnson, all of the United States Environmental Protection Agency, Office of Solid Waste, provided guidance and review.

[Note: No changes were made to this document in response to OMB review.]

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# 1. INTRODUCTION

The disposal of mercury-containing fluorescent lamps and the status of these lamps under the Resource Conservation and Recovery Act (RCRA) is a controversial issue. To further our understanding of lamp disposal issues, the U.S. Environmental Protection Agency (EPA) developed the *Mercury Emissions Model*, which estimates mercury emissions from the disposal of fluorescent lamps. This document presents instructions on how to use the basic features of the model. It is intended for those who wish to use the model and are unfamiliar with relational databases.

A companion document, *Mercury Emissions From the Disposal of Fluorescent Lamps*, presents the assumptions behind the model. This user's manual will first answer some basic questions and, in subsequent chapters, will demonstrate how to use the model. Please note that, since this user's guide was prepared, EPA has added updated data and disposal trees to the model for the baseline, conditional exclusion (CE) option, and the universal waste (UW) option. These new scenarios are referred to in the final model as Baseline/CESQG, CE/CESQG, and UW/CESQG, respectively. For the most part, this user's guide still refers to the original scenarios included in the draft model (i.e., Base Case, CE Option, UW Option); and therefore, some of the user screens shown in this guide may not exactly match the user screens that you will see when you access the final model. However, the instructions herein apply equally well to the final model.

Upon accessing the *Mercury Emissions Model*, you'll find the help system especially useful. To access the help system, simply press < F1 > on any screen or item.

**Q. What does the model do?**

A. The model estimates annual mercury emissions from lamp disposal for the period 1992 through 2007 under a variety of RCRA policy options, and cumulative emissions during the period 1998 - 2007 under various RCRA policies. Although the model uses the period 1992 - 1997 to initialize, you may implement a policy option in 1998 or any later year. It provides a central emissions estimate, a high emissions estimate, and a low emissions estimate.

**Q. What kind of computer will I need?**

A. You will need a PC compatible machine (486 or better) with at least 25 Megabytes (MB) of free hard drive space and a color monitor.

**Q. Do I need any special software to run the model?**

A. No. You will, however, need Windows 3.11 or Windows 95. You will be able to develop your own scenarios and input assumptions without any special software on your computer. The model is a relational database, and is programmed in Microsoft ACCESS, but you do not need ACCESS to run the model. Having ACCESS allows you to modify the underlying code, or create new outputs, and may also in certain circumstances improve the stability of the system.

**Q. Who can I contact about the model?**

A. If you have questions about the final model, or would like a copy, you can contact Lyn Luben of EPA's Office of Solid Waste. He can be reached at (703) 308-0508.

**Q. Is the model complicated to use?**

A. Somewhat, but technically oriented people should be able to pick it up fairly easily. Mercury emissions resulting from lamp disposal are complex. Our desire to provide users sufficient flexibility to conduct their own complex analyses leads to a multifaceted model. Once you understand how the model functions, you will be able to conduct your own analysis on this complex issue.

**Q. Do I need to know anything prior to using the model?**

A. We will be assuming you have read the companion report describing the analytical results, and that you have some knowledge of lamps, RCRA, and lamp issues. As a test, if you do not know what a T8 is, please stop and read the companion report.

**Q. What are the most important things to remember?**

A. The most important thing to remember is that the model estimates emissions from scenarios. Scenarios are composed of:

- A Base Case - The base case establishes a reference for comparing energy savings from various policy options.
- A Growth Option - Growth Options set the rate at which commercial building space in the United States grows.
- A Mercury Content Option - Mercury Content Options set the mercury content of lamps by type of lamp and by year.
- A Lamp Use Option - Lamp Use Options set the patterns by which the various types of lamps are used in buildings, and the rate at which they are disposed.
- A National Disposal Option - National Disposal Options establish the waste management of lamps (*e.g.*, by lamp type, by building type, and by year), and the emissions rates of the steps in the management process.

Another key to understanding the model is that most (but not all) data elements are structured by building group (*i.e.*, large buildings, medium-size buildings, and small buildings), lamp type (*e.g.*, T8, T12) and year. Thus you will be free to vary the disposal of lamps as a function of building size, lamp type, and year.

**Q. Is there anything else to tell me about before we begin?**

A. Yes. The model has the capability to account for differences in disposal patterns as a function of state; *i.e.*, you can vary the disposal patterns among states, and estimate emissions on a state basis. The model has also been designed to provide the user with the option to include under the Baseline/CESQG and CE/CESQG scenarios those states that regulate lamps under State programs less stringent than the Federal program (referred to in the model as UW States). However, we are not going to describe this feature as this is beyond the scope of this user's guide.

One last important note. While developing the model, test users without ACCESS encountered difficulties with a single left click system. **Therefore, everything in the model responds to a double left click of the mouse.** In the subsequent chapters of this guide, we will get you started running scenarios, show you how the model functions, and help you to develop your own scenario.

# 2. GETTING STARTED

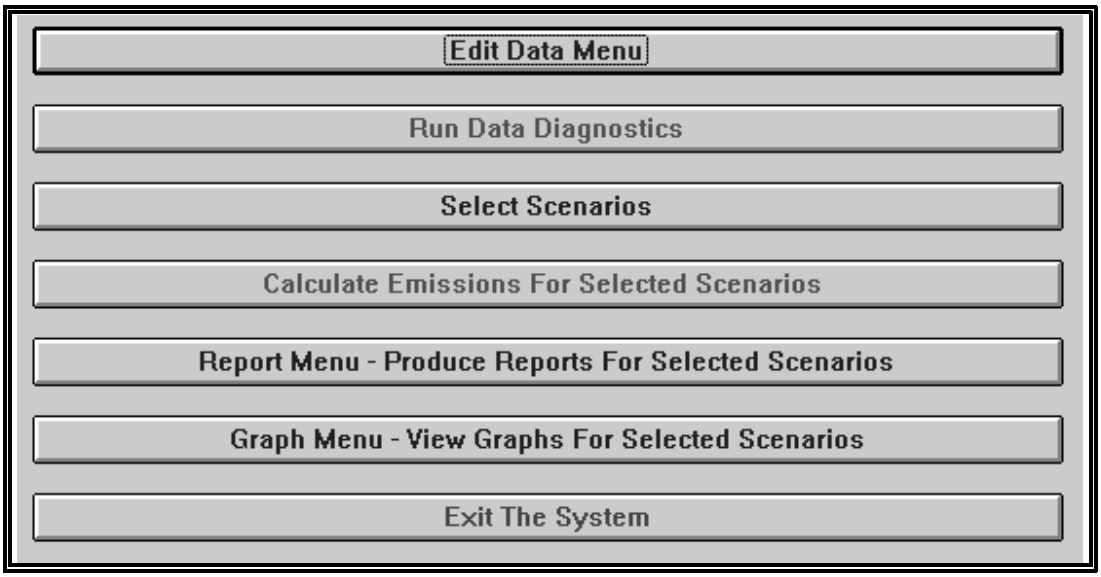
In this chapter we will get you started by explaining how to download the model. In later chapters, we will run some scenarios and review the reports and graphs the model provides. Please have the model pre-loaded and up on your computer as you read this step-by-step guide.

## 2.1 INSTALLING THE MODEL

To install the model, simply place the CD-ROM in the appropriate disk drive. Enter the File Manager program and select the file entitled "setup.exe" from the CD-ROM drive. You will then be guided through the process of installing the model on your computer. You will be given the option of selecting the directory under which you wish to place the model. Please keep in mind that the model is approximately 25 MB in size. If you do not have the necessary space on your computer, you will be notified to that effect by the setup program.

## 2.2 RUNNING THE MODEL

You should now have a screen icon entitled "Mercury Emissions Model." Please double click on the icon. You should be looking at the main menu screen which looks as follows:

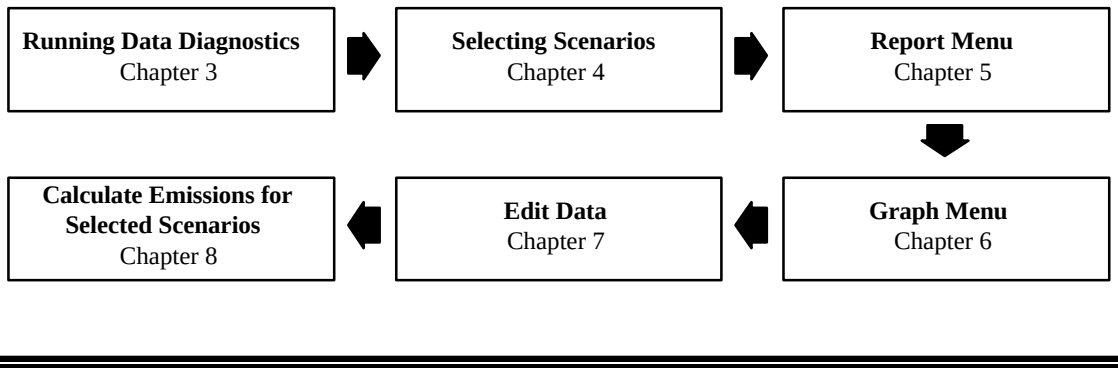


Following is a description of each selection on this menu:

- **Edit Data Menu**. This section of the model allows you to change scenarios and develop your own scenarios on which to base mercury emissions from the disposal of fluorescent lamps. Most of our time will be spent in this portion of the model.
- **Run Data Diagnostics.** After you develop your own scenario, this built-in utility that checks for common data errors. Always run this utility after making changes to a scenario or developing your own scenario.
- **Select Scenarios.** In this section of the model you select the scenarios you wish to run and analyze.
- **Calculate Emissions for Selected Scenarios.** This bar runs the model for the scenarios you have selected.
- **Report Menu - Produce Reports for Selected Scenarios**. This section of the model provides you with a selection of standard reports, containing the outputs for the model, in a report format.
- **Graph Menu - View Graphs for Selected Scenarios**. This section of the model provides you a selection of standard reports, containing the outputs for the model, in a report format. Only results for scenarios that were selected in the Select Scenarios portion of the menu are reported.
- **Exit the System.** Double-clicking on this bar returns you to Windows.

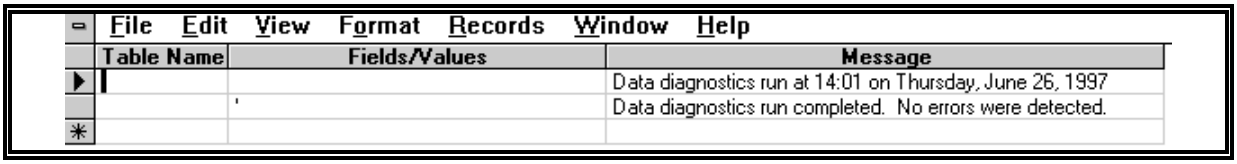
This user's guide will walk you through the major functions of the model. Figure 2-1 illustrates the steps we will follow.

**Figure 2-1: Mercury Emissions Model - Process Flow Chart**



# 3. RUNNING DATA DIAGNOSTICS

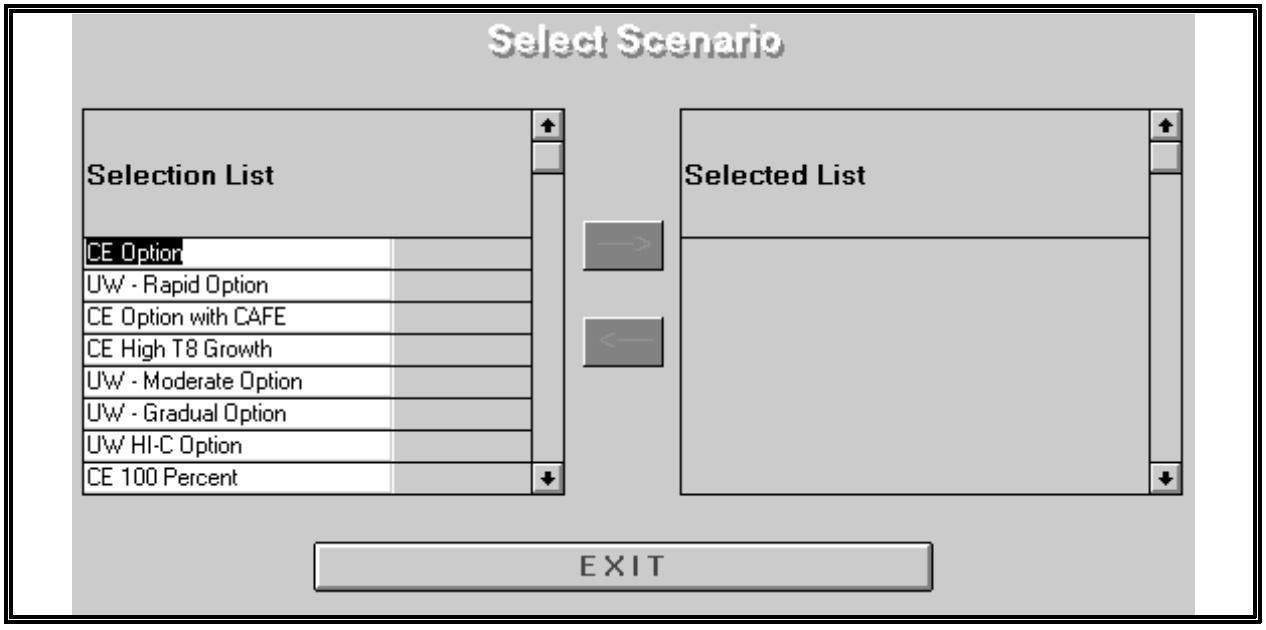
To begin, double click on **Run Data Diagnostics** and wait until the run screen, as shown below, appears. This utility provides a check to insure that no errors are present in the data. This screen shows an example of a data diagnostic without any errors present.




If you build a scenario and have errors, the data diagnostics utility will display error messages. We strongly recommend that you run this utility each time you start the model or make changes to the underlying data. Now close the screen by selecting "Close" from the File menu. This will return you to the main menu.

## 4. SELECTING SCENARIOS

**Next, let's run some scenarios and look at the outputs. Please double click on the Select Scenarios bar. You should now see a screen with two boxes, one entitled Selection List and one entitled Selected List.**




**The box on the left, Selection List, contains the scenarios that are available to you now, but have not yet been selected; *i.e.*, the scenarios we have provided to you. The model will run the scenarios you select; *i.e.*, those you move into the Selected List box. Please move CE Option and UW Moderate Option into the Selected List by first clicking on them and then clicking on the arrow pointing toward the selected list. Then exit the screen by double clicking the "Exit" bar.**

# 5. REPORT MENU

**Let's view the outputs of the model, starting with the reports. Please double-click on the Reports Menu bar on the main menu. You are now viewing a list of the available reports.**


**You may print these reports by selecting "Print" from the File menu. Table 5-1 provides a list of reports and a summary of the function of each individual report.**

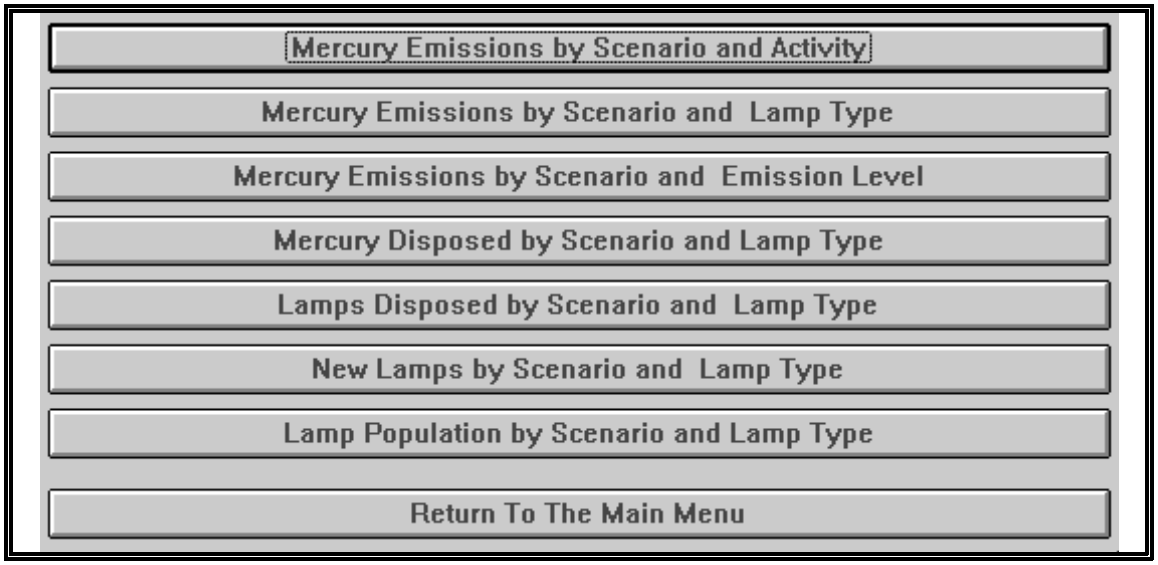
**Table 5-1. Report Name and Function**

| Report Name | Function |
|---|---|
| **Annual Mercury Emissions by Scenario and Activity** | **Mercury Emissions by Scenario, by year, and by management step or unit (*e.g.*, Subtitle C Transport)** |
| **Mercury Emissions By Scenario and Activity** | **Cumulative mercury emissions for each step in the management of lamps in a given scenario** |
| **Mercury Emissions by Scenario Emissions Level and Year** | **Total mercury emissions for each year under each scenario** |
| **Mercury Emissions Detail Report** | **All details calculated by the model** |
| **Mercury Emissions Savings on Energy Generation** | **Mercury emissions avoided from coal-fired utility boilers as a result of saving energy by installing energy-efficient T8s** |
| **Net Mercury Emissions by Scenario** | **Emissions from disposal of lamps less the emissions saved from utility boilers** |
| **Lamps Disposed by Scenario, Year, Building Group, and Lamp type** | **Details on the disposal of lamps** |
| **Lamp Population Share by Scenario, Year, and Lamp Type** | **Details on lamp populations by lamp type** |
| **Lamp Population and Disposal Detail** | **Additional details on lamp disposal patterns** |

**As we indicated previously, users with ACCESS can modify the reports or build new reports, while users without ACCESS do not have this capability. You may want to view some reports to get a feel for the data content. When you are finished, please exit the screen and return to the Main Menu.**

# 6. GRAPH MENU

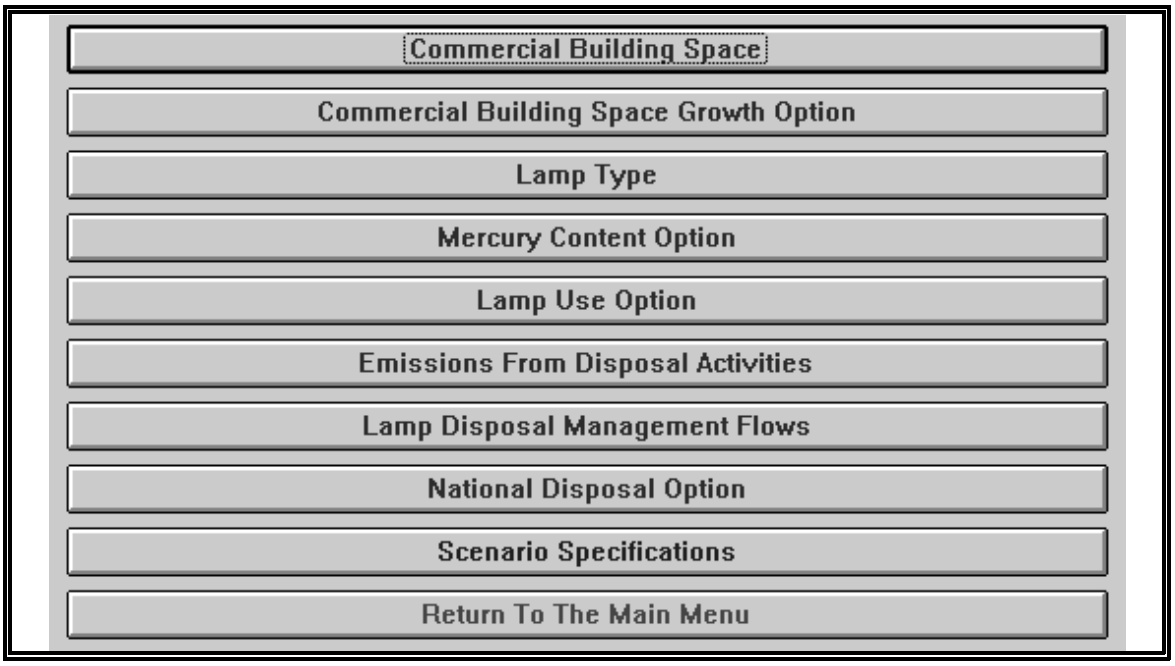
**To view the data in graphic form, double click on Graph Menu. The resulting screen displays the graphs available within the model.**




**Simply double click on some of the graphs to see a visual display of the outputs. Many of the graphs and reports can be exported to Excel spreadsheets. This will allow you to export data from model runs for your own detailed analysis. If you chose to export graphs, they will be given the filename 'graphdat.xls.' Note that if the export button does not appear, you must update the graph. Once you have completed this, the button should appear if you reenter this section. When you are finished, please return to the Main Menu.**

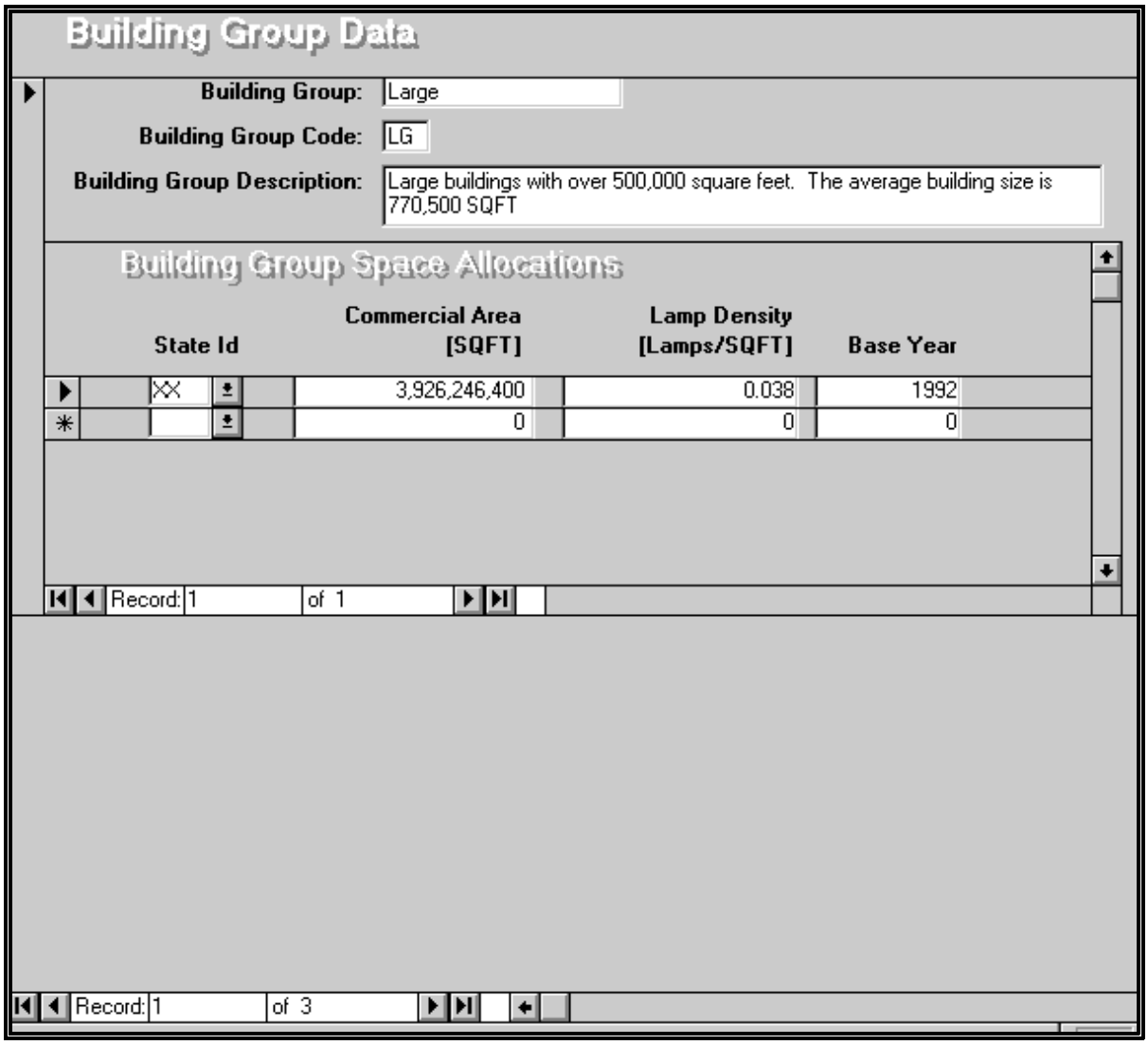
# 7. EDIT DATA MENU

**The Edit Data Menu allows you to develop your own scenarios, or to modify the assumptions behind the scenarios we have provided to you. Because this section of the model provides many user options, we will describe the section in some detail. Please double click on the Edit Data Menu bar. You should see a screen that looks as follows:**




## 7.1 COMMERCIAL BUILDING SPACE

**This section of the model allocates commercial floorspace into large, medium, and small buildings.**




**Starting at the top of the screen:**

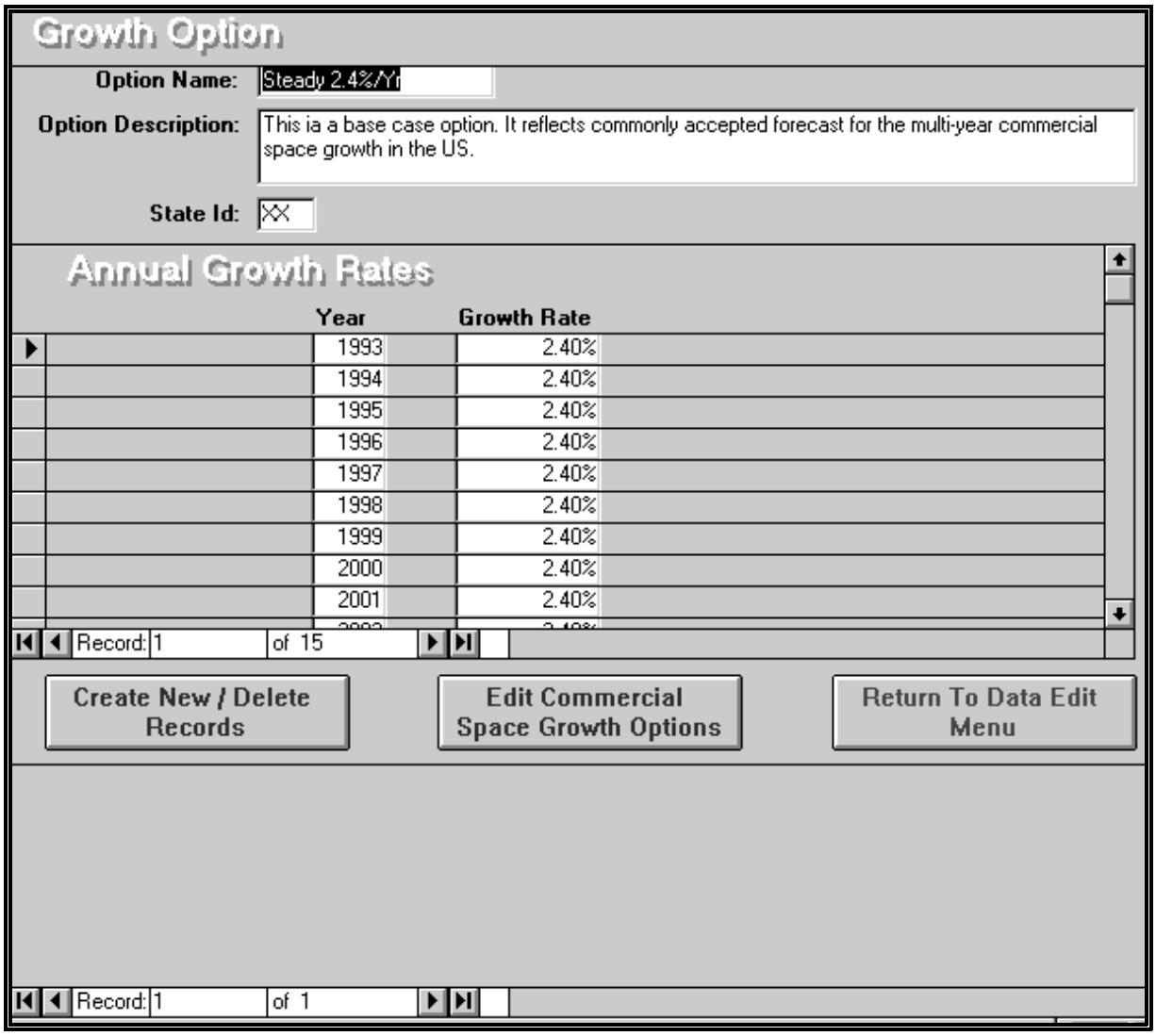
- **Building Group 'Large' indicates we are looking at large buildings.**
- **Building Group Code: 'LG' - This is a two-letter code used by the model.**
- **Building Group Description: This provides a general description of the building type.**

***"Building Group Space Allocations"*** **shows the amount of space allocated to the building group, the lamp density in large buildings, and the base year (1992 - the year that the commercial**

**space is estimated for). Users are free to change lamp density, or the square footage allocated to a type of building.**
***State Id* "XX" indicates we are running the entire nation as a whole, and this data element relates to the capability of estimating emissions at a state level.**
**By clicking on the record number at the very bottom left of the screen, you can see our assumptions for each of the building types. When you design your own scenario, you are free to make other assumptions. Now, please close the screen, return to the Edit Data Menu, and enter the Commercial Building Space Growth Option portion of the model.**

## 7.2 COMMERCIAL BUILDING SPACE GROWTH OPTION

**Because the overall demand for lighting changes with economic activity and with the construction of new buildings, we estimated a rate of increase in the demand for lighting, which translates into a greater total number of lamps used each year. As you can see, we assumed a growth rate of 2.4 percent per year for the entire modeling period. You can change these assumptions if you wish. Because the model calculates total floorspace and then allocates the floorspace into the building groups, the growth rate for all types of buildings must be the same.**




## 7.3 LAMP TYPE DATA

**Viewing the Lamp Type Data section of the model will enable you to examine our basic assumptions about types of lamps. The database contains six types of lamps, one of which is a dummy variable**

enabling us to populate newly constructed space with lamps. Only two (T12 and T8) of the remaining five lamp types are currently used in the model.

**Lamp Type Data**

| Lamp Type Name | Code | Description | Lamp Life [Years] Average | Maximum | Energy Saving Over Base Lamp [kWh/Year] | Delamping Rate | Base Lamp Energy Cons. [kWh/Year] |
|---|---|---|---|---|---|---|---|
| Low HG T12 | CL | Low Mercury T12 | 4 | 6 | 0.0 | 1.00 | 180.00 |
| Low HG T8 | 8L | Low Mercury T8 | 3 | 6 | 56.0 | 0.85 | 180.00 |
| None | NA | Dummy lamp type to handle previou | 1000 | 1000 | 0.0 | 1.00 | 0.00 |
| T12 | 12 | T12 | 4 | 6 | 0.0 | 1.00 | 180.00 |
| T8 | T8 | T8 | 4 | 6 | 56.0 | 0.85 | 180.00 |
| TC Pass T8 | 8H | High Mercury T8 that passes TCLP | 3 | 6 | 56.0 | 0.85 | 180.00 |
| | | | 4 | 4 | 0.0 | 0.00 | 180.00 |

Lamp types incorporated into the basic structure of the model include:

1. Low Mercury T12 - These lamps are currently manufactured and sold in the US, but data regarding populations were insufficient to allow analysis of this lamp type. Therefore, while the basic structure of the model accommodates this lamp type, we did not include it in the population estimates.
2. Low Mercury T8 - This type of lamp, which is defined as a T8 passing the Toxicity Characteristic (TC) due to inherently low mercury content, has not yet been developed. No populations are estimated for this lamp type.
3. None - Dummy variable used to seed the population of new floorspace.
4. T12 - Standard T12 lamp. This lamp is used in the model.
5. T8 - Standard T8 lamp. This lamp is used in the model.
6. TC Pass T8 - This lamp is assumed to be a T8 with relatively high mercury content, that passes TC due to changes in phosphor chemistry. Such lamps may exist in the near future, but they are not implemented in the model.

Lifetimes for T12s and T8s presented in the data tables are four years for average life and six years for maximum life. The model uses the average life and the maximum life of four and six years to estimate disposal rates. Specifically, the model assumes that lamp failures are described by a binomial distribution as follows:

$$\text{Fraction of Failed Lamps} = \frac{K!}{N!(K-N)!} P^N (1-P)^{(K-N)}$$

Where: N = cohort year, which ranges from 1 to 6,
K = maximum lamplife (N = 6), and
P = probability a lamp will not fail in each year (P = 0.67)

Thus, in a given year (*e.g.*, 2005) the model estimates the number of lamps replaced by group relamping, and then uses the binomial distribution to estimate the number of lamps failing due to age for the years 2005, 2004, 2003, 2002, 2001, 2000, and 1999. Shortening the average or maximum lamplife will increase the number of lamps undergoing disposal, while lengthening lamplife will have the opposite effect.

Building owners and operators conducting lighting upgrade programs tend to "delamp"; *i.e.*, reduce the number of lamps lighting the space. Delamping rates vary, with some owners and operators choosing not to delamp and others making large changes.

Therefore, in estimating the population of T8s we do not assume a one-to-one correspondence with T12s. A one-to-one replacement rate is assumed for replacements of T12s with T12s, and T8s with T8s, but not for a transition from T12s to T8s. Analysis of data from the Green Lights Program indicates that Green Lights participants have a delamping rate of 0.85 when changing from T12s to T8s. This is the delamping rate used in the model (*i.e.*, 100 T12s will be replaced by 85 T8s).

Replacement of T12 lamps with T8s yields energy savings, which in turn potentially reduces the mercury emissions from utility boilers through load reductions. To estimate energy savings the model calculates the energy consumption of typical T12 and T8 installations, and compares the energy usage. Most T12 lamps are used with "energy efficient magnetic ballasts," and there is a mix of 40-watt and 34-watt T12 lamps. The American National Standards Institute (ANSI)-rated consumption for two 40-watt T12 lamps on an EE magnetic ballast is 88 watts. The consumption of two 34-watt T12 lamps on the same ballast is 72 watts. We used the average of 80 watts per ballast to estimate an average energy use of 40 watts per T12 lamp.

The calculation of watts per lamp for T8 lamps is based on the judgment of lighting professionals that two T8 lamps operate on one electronic ballast. ANSI reports total wattage consumption per ballast of 62 watts. Thus, we estimate 31 watts per T8 lamp.

Based on Green Lights data, we assumed that, on average, the total hours of lighting per year are 4,000 for T8 lamps and 4,500 for T12 lamps. Thus, we calculated energy uses of 124 kwh/lamp/year for T8 lamps and 180 kwh/lamp/year for T12 lamps. From this, we estimate a per lamp energy savings of 56 kwh per lamp. Please note that because of delamping, actual energy savings are higher than the 56 kwh/lamp. Actual savings, including delamping, are calculated as follows:

Energy Savings for a T8 Population = $T8\_pop(f*e_s + (1-f)*e_{T12})$

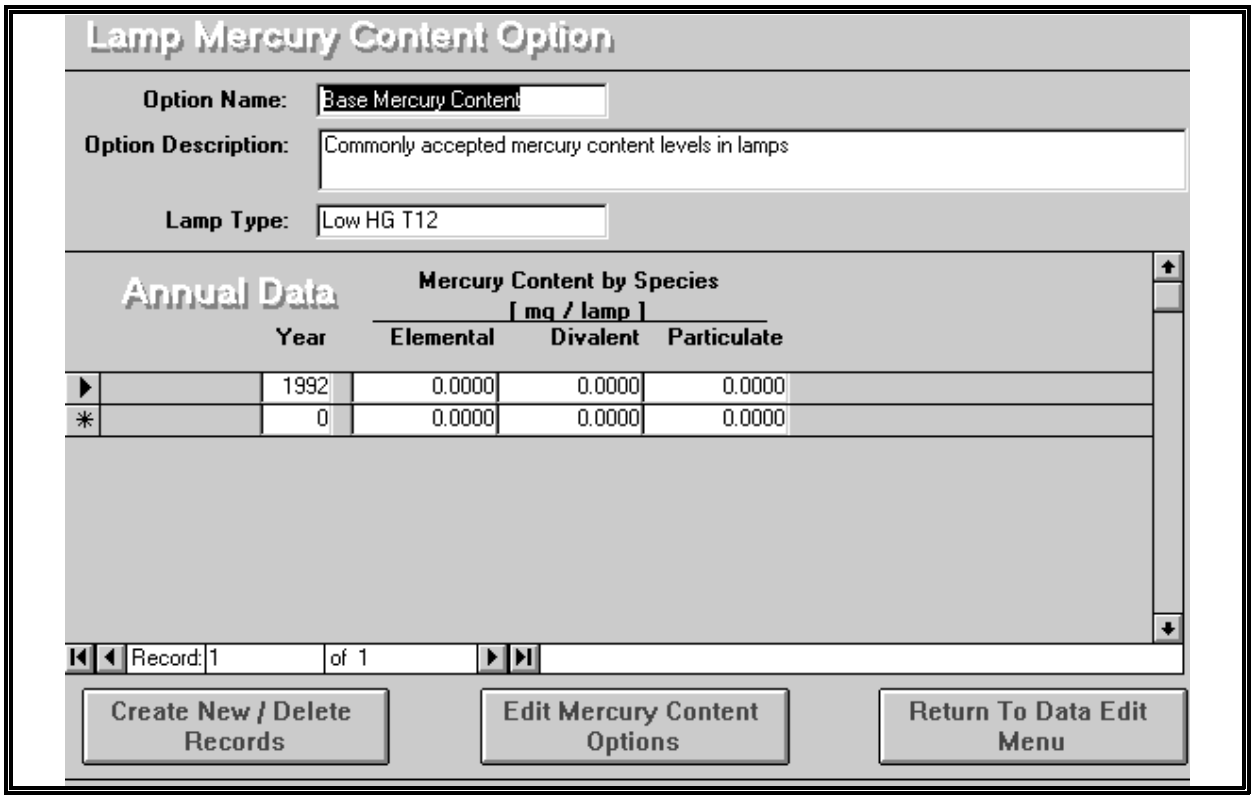
Where

| | | |
|---|---|---|
| T8_pop | = | The T8 population |
| f | = | The delamping factor, which is estimated as 0.85 |
| $e_s$ | = | The per lamp energy savings without delamping |
| $e_{T12}$ | = | The energy use of a base T12. |

Please exit the **Lamp Type** section, and enter **Mercury Content Option**.

## 7.4 LAMP MERCURY CONTENT OPTION

The **Mercury Content Option** portion of the model contains information regarding the mercury content of each lamp type at the end of the lamplife.




Information in the Mercury Report to Congress indicates that mercury deposition rates vary dramatically among species.[1] Therefore, it was decided to track mercury content in lamps by species; *i.e.*, elemental mercury, divalent mercury, and particulate mercury. Data on overall mercury content were provided to EPA at meetings with manufacturers during the summer of 1996. Manufacturers provided estimates of current and future mercury content, which were composited into an estimate of total mercury content for T12s and T8s.

Please note that, because data on mercury content by species and mercury emissions by species are considered highly uncertain, most model outputs are in total mercury. The mercury content of lamps depends upon the type of lamp as well as the year of manufacture. Information from lamp manufacturers indicates that substantial reductions in the mercury content of lamps have already occurred, and more reductions are anticipated.

Users are of course free to make assumptions which differ from ours. As shown on the screen, users can vary either the mercury content, the year in which a particular mercury content is achieved, the relative fraction of the various species, or all of the above. Please note that for any option and lamp type, the specification of mercury content carries over from one year to the next until a new value is given.

Please exit this screen and enter the **Lamp Use Option** section of the **Edit Data Menu**.

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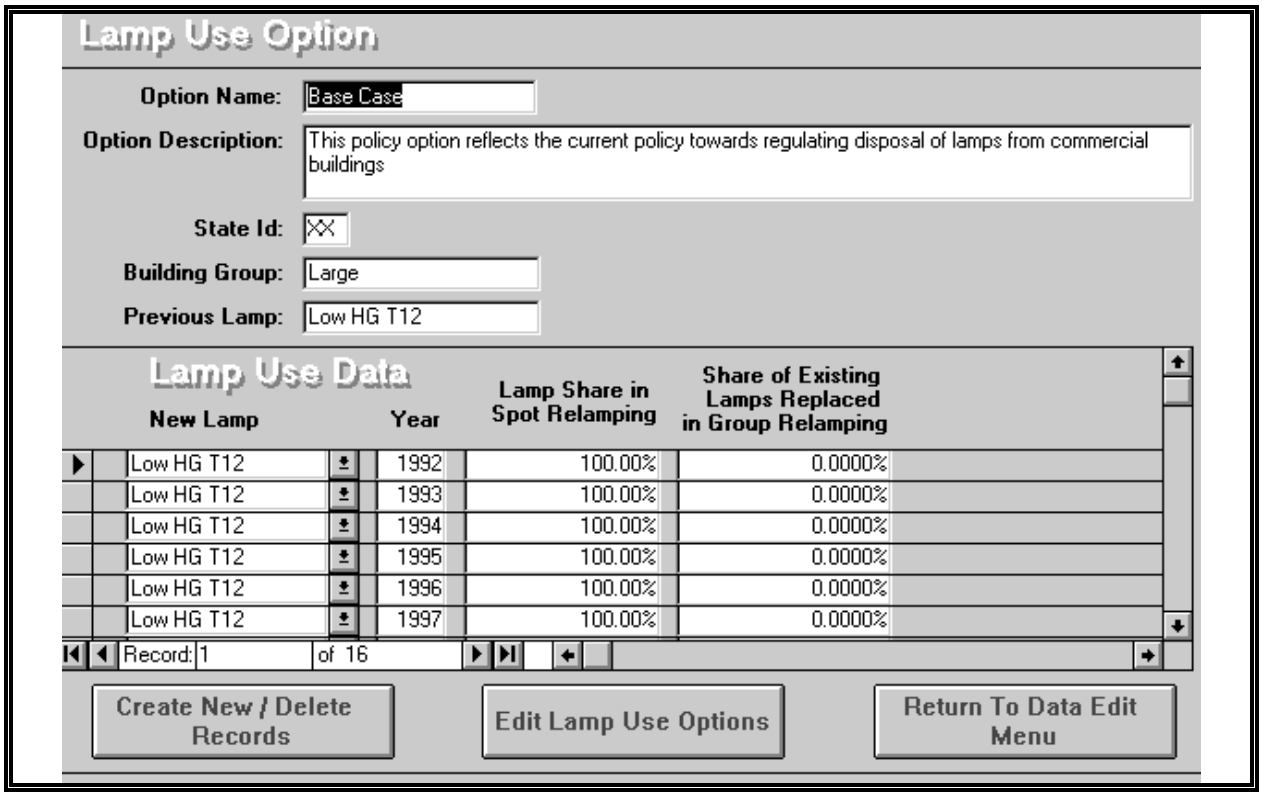
[1] Mercury Study: Report to Congress. EPA 452/R-97-004. December 1997.

## 7.5 LAMP USE OPTION

This section is the hardest part of the model for most people to understand. In essence, this section of the model fills the floorspace with the types of lamps, by defining rules for lamp replacement.




As you can see on the screen, replacement rules can change each year of the modeling period. Rules for lamp replacement are defined by :

**Option Name** Each option can have its own lamp populations.

**Building Group** The replacement rules and therefore populations can differ by type of building.

**Previous Lamp** Previous Lamp Type indicates the type of lamp that is being replaced (*e.g.*, T12 or T8).

At the very bottom of the screen, click on the record advance in the lower left-hand corner until "Base Case" appears in the *Option Name* block. Continue until the previous lamp type is "none;" please remember that "none" is the dummy lamp type allowing us to populate newly constructed floorspace.

Based on information from the EPA Office of Air and Radiation (OAR), the model assumes that prior to 1993, 100 percent of commercial buildings are populated with T12s. The percentage changes to 85 percent T12s and 15 percent T8s from 1993 to 1997. After 1997, the percentage becomes 50 percent T12s and 50 percent T8s and remains constant thereafter.

Clicking to the next record, we have replacement rules for existing T12s in large buildings (*i.e.*, "Building Group" is "Large," and "Previous Lamp" is "T12"). Now we are defining the replacement rules for T12s in large buildings. The "New Lamp" column indicates the potential replacement lamp for our previous lamp (*i.e.*, T12), the "Year" column indicates the year in which the rules apply, the "Lamp Share" column indicates the percentage share of the replacement lamp in spot relamping operations, and the "Group Relamping" column indicates the fractional share of replacements in group relamping operations.

Let's look at the first two rows as an example. First, we have T12s in 1992 with a spot relamping share of 100 percent and a group relamping share of 0 percent. This means that all of the T12s in spot relamping were replaced with new T12s (*i.e.*, 100 percent share) and no T12s were replaced with new T12s in a group relamping operation. Overall, we always assume that in spot relamping T12s replace T12s, and T8s replace T8s. We make this assumption because the fixtures used by these lamps are different. T12s cannot be placed in unmodified fixtures, nor can T8s be placed in unmodified T12 fixtures.

In the second row we have T8 1992, 0 percent share of spot relamping, 6.9 percent share of Group Relamping. This means that no T8s replaced T12s in spot relamping operations, and that T8s replaced 6.9 percent of the existing T12s as part of Group Relamping operations. Examination of the rest of the data set will provide you with our replacement rules for T12s. The model gives you the capability to develop your own replacement rules.

Please click to the next record, which defines the replacement rules for T8s in large buildings. In these rules T8s always replace T8s. Because some building owners and operators conduct group relamping after converting to T8s, the model allows for T8s to be replaced with T8s as part of a group relamping process. The 20 percent share for group relamping equates to about 60 percent of the buildings equipped with T8s conducting group relamping (*i.e.*, 0.60 share times 3 years equals 0.20 percent of the total population).

Feel free to examine the replacement rules for the various types of lamps. As currently implemented, note the following:

- In spot relamping, the same lamp always replaces the previous lamp.
- The replacement rules do vary with building type, with T8s having higher penetration rates in larger buildings.

As always, the model allows you to develop your own replacement rules.

## 7.6 REVIEW

Let us take a minute and see what we have done, where we are, and where we need to go. To estimate mercury emissions from the disposal of lamps, we need estimates of the number of lamps undergoing disposal each year, and the mercury content of those lamps. In the previous sections we have:

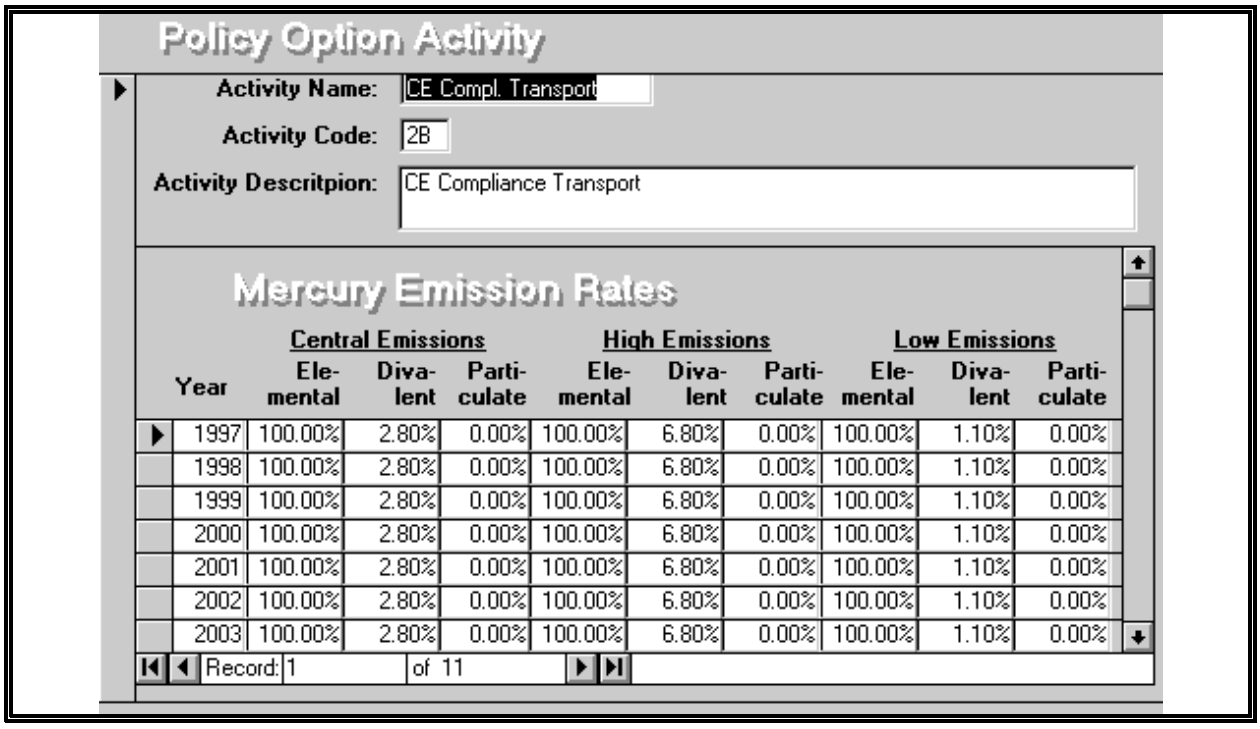
- Allocated floorspace among types of commercial buildings;
- Populated those buildings with lamps of various types;
- Estimated the life of lamps, which we use to estimate the number of lamps disposed as a result of spot relamping; and

- Estimated the number of lamps disposed as a result of group relamping.

The model now has all of the information needed to estimate the amount of mercury entering the disposal system as a result of the disposal of fluorescent lamps. The next sections of the **Edit Data Menu** deal with the disposal system, and the estimation of emissions from the disposal system.

## 7.7 EMISSIONS FROM DISPOSAL ACTIVITIES

Double click on the **Emissions From Disposal Activities** bar in the **Edit Data Menu**. This section of the model contains emissions rates for disposal activities. The screen should look as follows:




As you can see, the upper portion of the screen contains the following information regarding each disposal activity.

| | |
|---|---|
| Activity Name | A unique name for the disposal activity. |
| Activity Code | A unique 2 character code for each disposal activity. |
| Activity Description | A brief description of the disposal activity. |

The lower portion of the screen contains the three emissions rates for the activity (*i.e.*, Central Emissions, High Emissions, and Low Emissions). Emissions rates may also vary by year, although we have not used this feature in any of our analysis. Emissions rates are expressed as percentages of the species emitted. For example, in the activity *CE Compliance Transport*, the elemental mercury emissions estimate is 100 percent. If the elemental mercury content of a T12 is 0.06 mg, each such lamp will emit 0.06 mg during this activity.

The model contains built-in waste management activities, and you may modify the emissions rates of these activities, or you may add additional waste management activities. We developed these activities to model the flow of wastes throughout the entire disposal system. Because emissions rates for each activity must be unique, we developed numerous units. The following are the disposal activities incorporated into the revised model:

- Dummy Units - To control waste flows we developed a series of dummy units, each of which has the precedent "Start." Dummy units have zero emissions, and include:
  - Start
  - Within the Baseline/CESQG:
    - Base Federal Start
    - CESQG
    - Non-CESQG
    - Subtitle D Management
    - Subtitle C Management
    - UW Compliance
    - UW Noncompliance
    - UW Start
  - Within CE/CESQG:
    - CE Compliance
    - CE Federal Start
    - CE Noncompliance
    - CESQG
    - Non-CESQG
    - UW Compliance
    - UW Noncompliance
    - UW Start
  - Within UW/CESQG:
    - CESQG
    - Non-CESQG
    - UW Compliance
    - UW Noncompliance
- Transport Units - These are activities involving the transport of lamps, and include:
  - Within the Baseline/CESQG:
    - Subtitle C Transport, UW Compliant Transport, or CESQG Recycling Transport. The transport of lamps to Subtitle C management units, such as landfills or recycling.
    - Subtitle D Transport, UW Subtitle D Transport, or CESQG Transport. The transport of lamps to Subtitle D management units, such as landfills or incinerators
  - Within CE/CESQG:
    - CE Comply Transport, UW Compliant Transport, or CESQG Recycling Transport. The transport of lamps to compliant units, such as certain Subtitle D Municipal Landfills.
    - CE Subtitle D Transport, UW Subtitle D Transport, or CESQG Transport. Transport of lamps to noncompliant units (e.g., incinerators).
  - Within UW/CESQG:
    - UW Compliant Transport or CESQG Recycling Transport. The transport of lamps to compliant units.

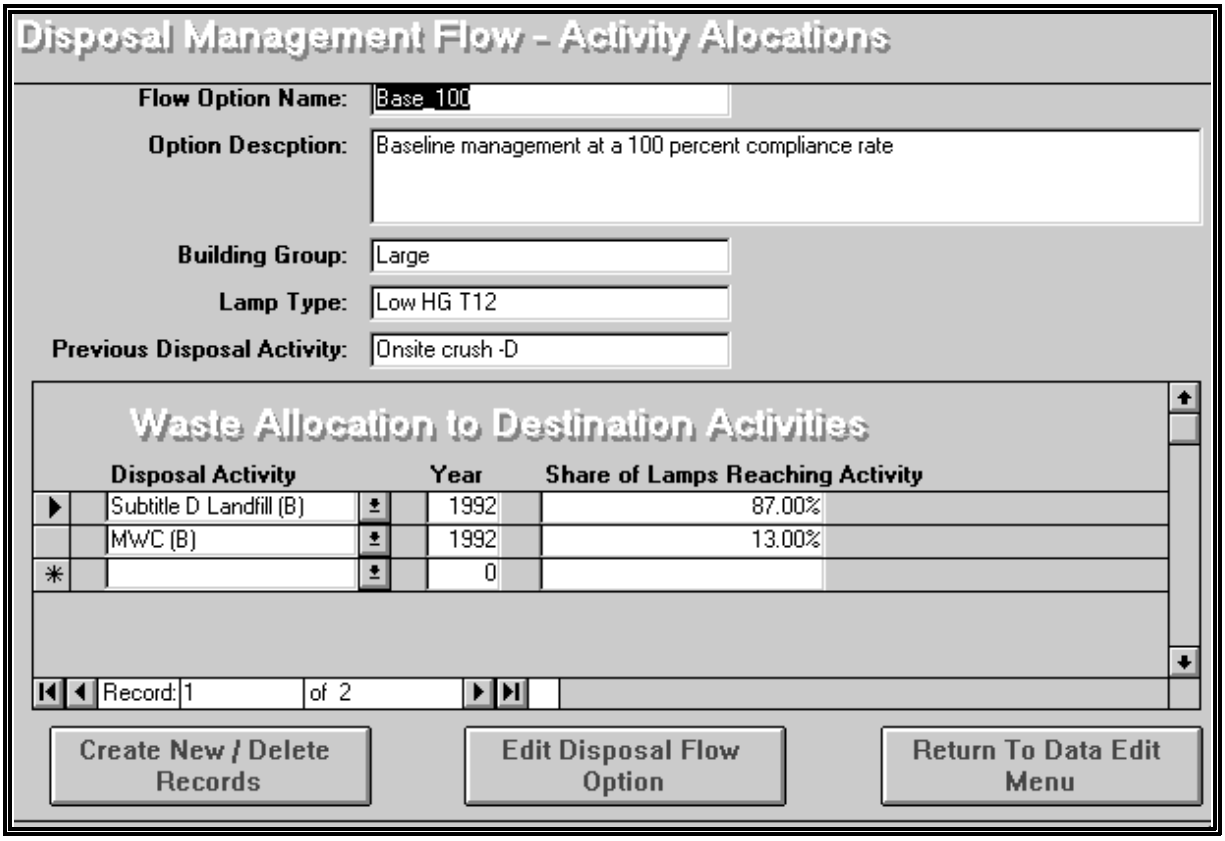
- UW Subtitle D Transport or CESQG Transport. The transport of lamps to noncompliant units.

- Crushing - These are activities involving the crushing of lamps, including:
  - Within the Baseline/CESQG:
    - Onsite Crush-C or UW Onsite Crush-C. The onsite crushing of lamps, with the remains being transported to Subtitle C management units, such as landfills or recycling.
    - Onsite Crush-D or UW Onsite Crush-D. The onsite crushing of lamps, with the remains being transported to Subtitle D management units, such as landfills or incinerators.
  - Within CE/CESQG:
    - Onsite Crush-C or UW Onsite Crush-C. On-site crushing in Subtitle C management.
    - CE Onsite Crush-D, UW Onsite Crush-D, or Onsite Crush-D. On-site crushing in Subtitle D management.
  - Within UW/CESQG:
    - ~~UW Onsite Crush-C or Onsite Crush-C. On-site compliant crushing.~~
    - UW Onsite Crush-D or Onsite Crush-D. On-site noncompliant crushing.
    - Landfills - These activities involve the landfilling of lamps.
  - Within the Baseline/CESQG:
    - Subtitle C Landfill or UW Subtitle C Landfill. A Subtitle C landfill.
    - Subtitle D Landfill or UW Subtitle D Landfill. A Subtitle D landfill.
  - Within CE/CESQG:
    - CE Subtitle C Landfill or UW Subtitle C Landfill. A Subtitle C landfill used in the compliant portion of the CE waste flow.
    - CE Subtitle D Landfill or UW Subtitle D Landfill. A Subtitle D landfill that does not comply with CE.
  - Within UW/CESQG:
    - UW Subtitle C Landfill. A Subtitle C landfill.
    - UW Subtitle D Landfill. A Subtitle D landfill.
- Recycling - These are activities involving the recycling of lamps, including:
  - Within the Baseline/CESQG:
    - Recycle Baseline C or UW Recycle.
  - Within CE/CESQG:
    - CE Recycle or UW Recycle.
  - Within UW/CESQG:
    - UW Recycle.
- Municipal Waste Combustors (MWC) - These are activities involving the combusting of lamps, including:
  - Within the Baseline/CESQG:
    - MWC or UW MWC.
  - Within CE/CESQG:
    - CE MWC or UW MWC.
  - Within UW/CESQG:
    - UW MWC.

In the next section we will see how these disposal activities are organized into a disposal system or tree. Please exit this screen, return to the **Edit Data Menu**, and enter **Lamp Disposal Management Flows**.

## 7.8 LAMP DISPOSAL MANAGEMENT FLOWS

This section of the model controls the flow of discarded lamps through the management system, and organizes the disposal activities into "trees."




As shown on the following pages, Figures 7-1, 7-2, and 7-3 present the current waste disposal flows. The organization of trees is by:

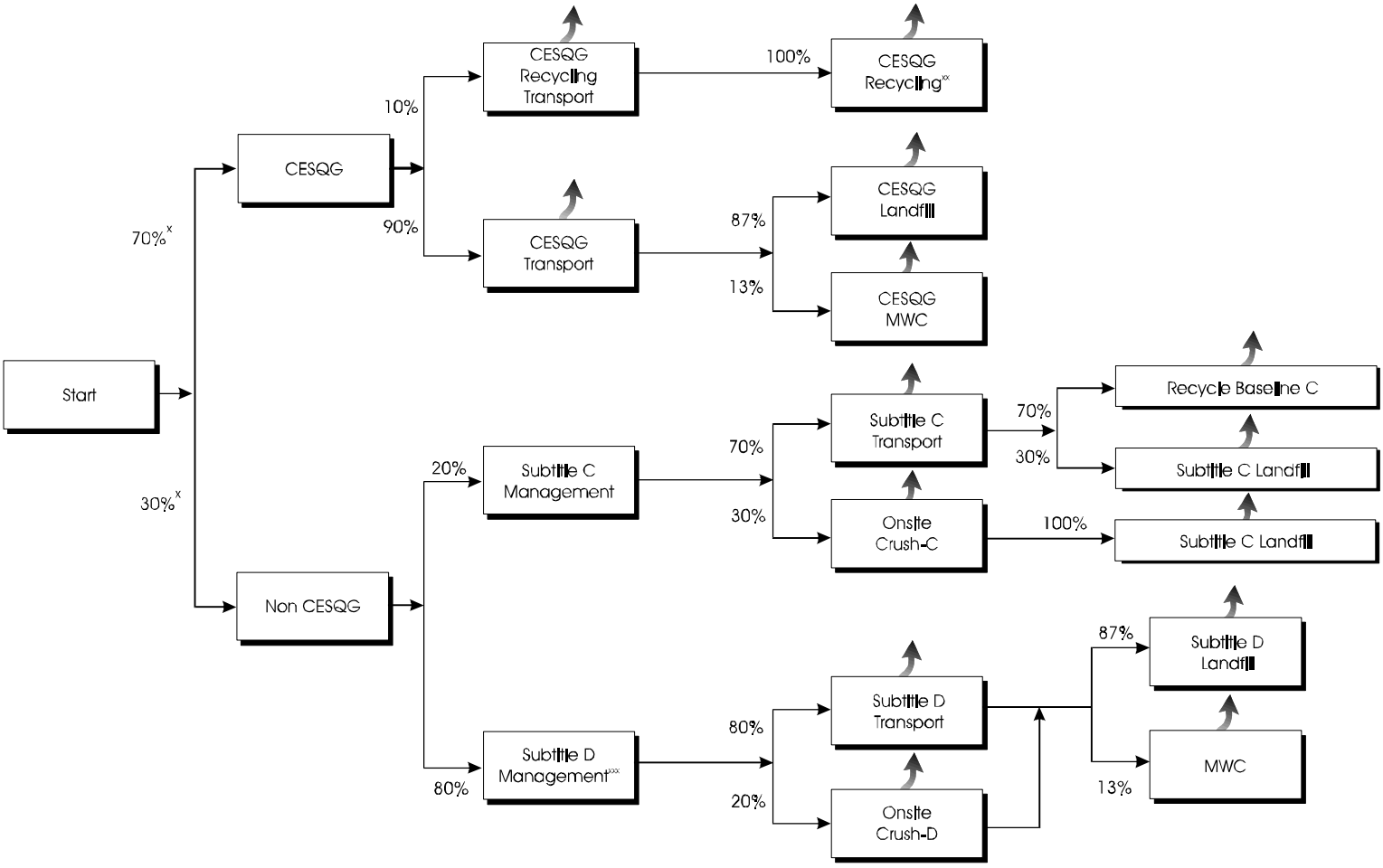
- *Option* - This is the name of the option to which the tree applies. This allows you to develop different waste flows for different options; *e.g.*, the waste flow for CE/CESQG will differ from Baseline/CESQG.
- *Building Group* - Lamps from different buildings may have different trees; *e.g.*, large buildings could be modeled with a different set of requirements than small buildings.
- *Lamp Type* - Different types of lamps from the same building type can have different trees. For example, you could build a tree that assumes future low mercury T8s are managed in a particular way, while other T8s are managed in a different way.
- *Year* - It is possible to vary the flow of waste within a tree by year.

The ground rules for developing a disposal tree are as follows:

- Each unit on the tree must be unique - *i.e.*, the same unit cannot appear in two places.

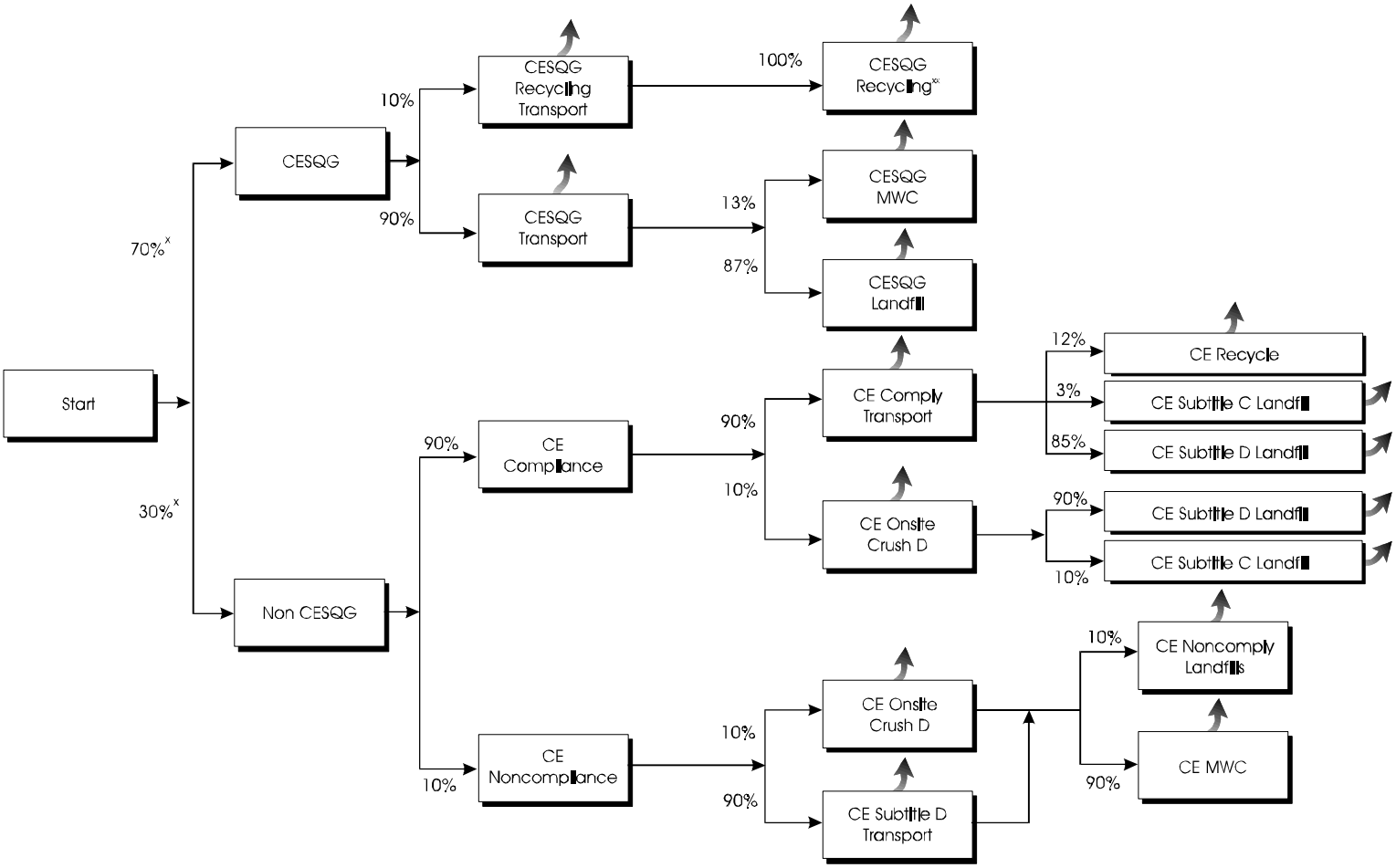
- Each unit on the tree may receive wastes from more than one ‘upstream’ unit.

**Figure 7-1. Baseline/CESQG Waste Flow/Disposal Tree**



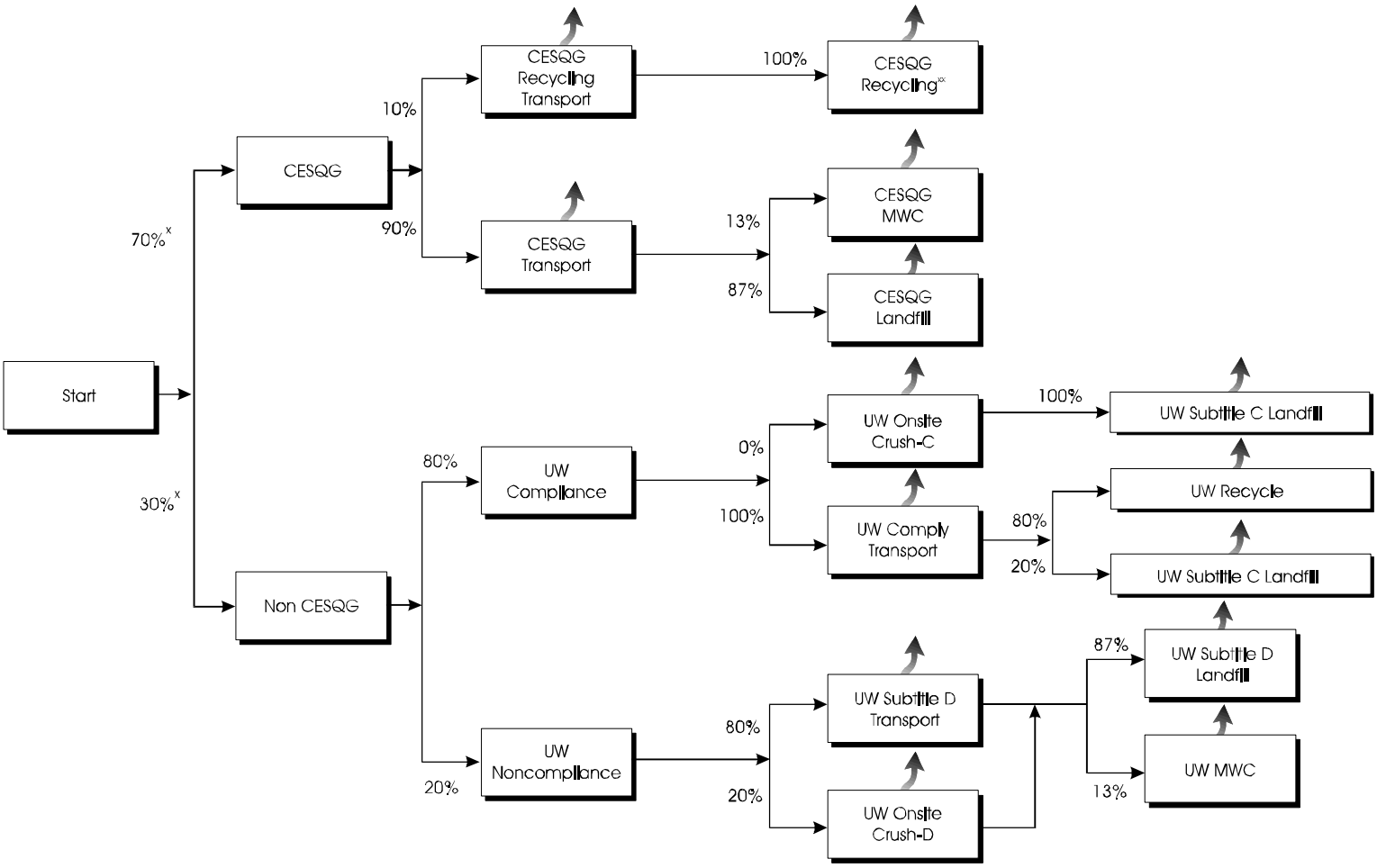

x Varies by year, 1998 partitioning coefficients are shown.
** Voluntary recycling.
*** Represents non-compliant lamp management.

**Figure 7-2. CE/CESQG Waste Flow/Disposal Tree**




x Varies by year, 1998 partitioning coefficients are shown.
xx Voluntary recycling.

**Figure 7-3. UW/CESQG Waste Flow/Disposal Tree**




x Varies by year, 1998 partitioning coefficients are shown.
** Voluntary recycling.

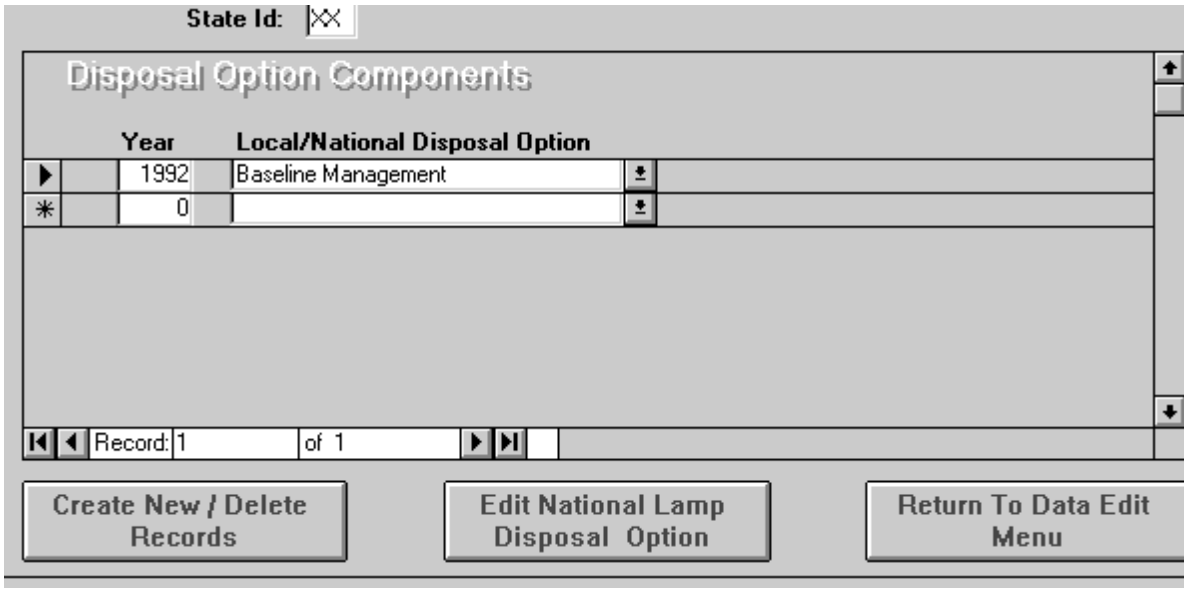
Several units on a tree may send waste to the same unit.
Now, advance to record 122 of 1440. Notice that you are in the Baseline management waste flow; large buildings; lamp type T12.
The key portions of the screen are the following:

- **Previous Disposal Activity**, which in this case is '*start;*' and
- **Waste Allocation to Destination Activities**. This box contains the following two activities: Subtitle D Management and Subtitle C Management. On the far right is shown the share of lamps from the previous activity (in our example the previous activity is '*start*' ) going to each of these two destination activities (*i.e.*, 80 percent of the lamps from *start* go to Subtitle D Management, while the remaining 20 percent go Subtitle C Management).

Advance one record to record 123 of 1440. Here we see that of those T12s from large buildings going into *Subtitle C Management* (the previous activity), 80 percent go into *Subtitle C Transport*, and the remaining 20 percent enter *Onsite Crush-C*. By following the disposal trees you can review their structure. Please note that disposal trees must consist of units that can be found in the **Emissions From Disposal Activities** section of the model. The **Emissions From Disposal Activities** section defines activities existing within the model and in attempting to use an undefined activity, you may be attempting to use a unit that does not exist.

## 7.9 NATIONAL DISPOSAL OPTION

**THE NATIONAL DISPOSAL OPTION SECTION COMBINES WASTE FLOW OPTIONS TO MODEL A POLICY. PLEASE ENTER THIS SECTION OF THE MODEL. THE SCREEN SHOULD LOOK AS FOLLOWS.**



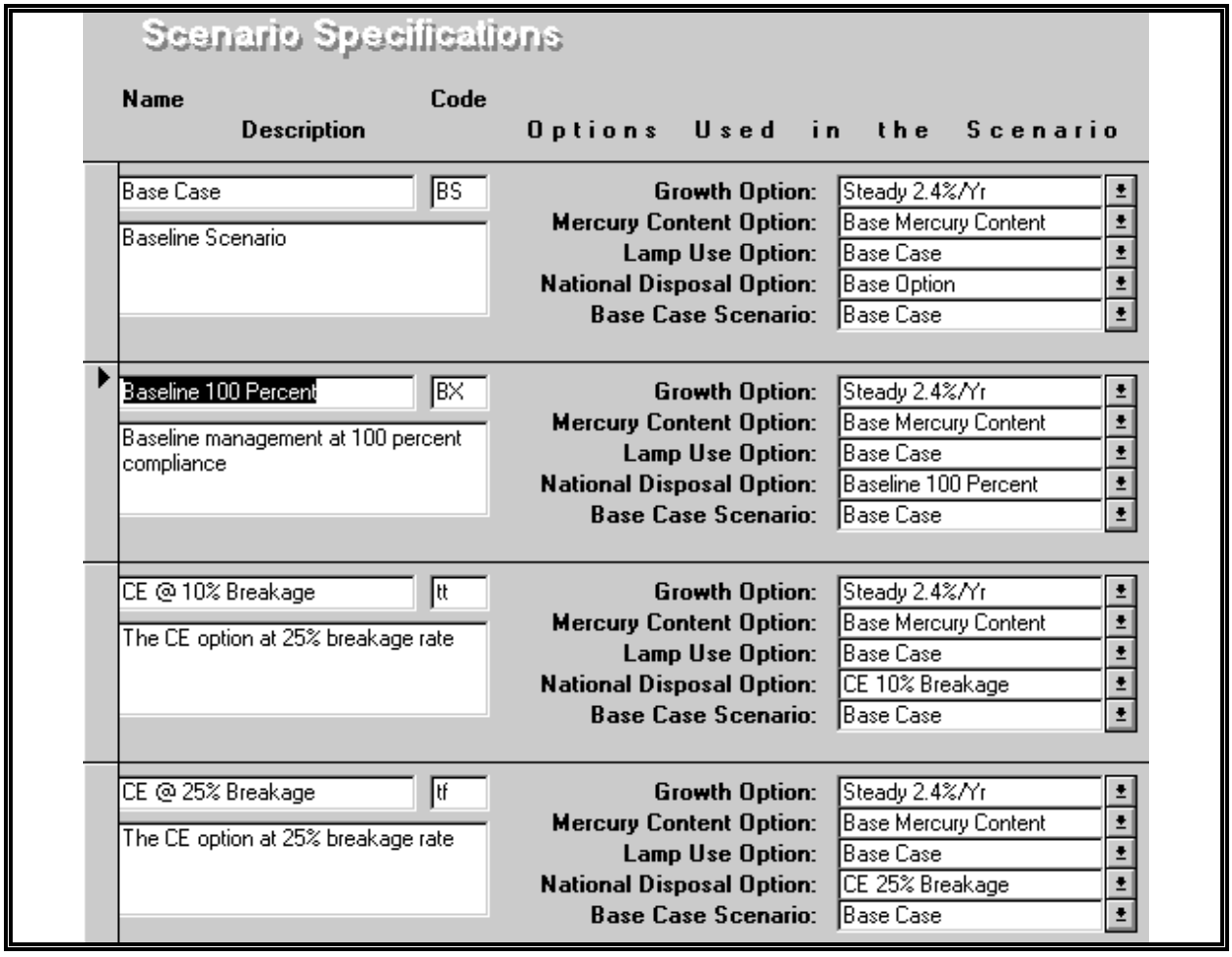
**NOW GO TO RECORD 10 OF 23, WHICH IS *CONDITIONAL EXEMPTION*. THE BOX ENTITLED "DISPOSAL OPTION COMPONENTS" LISTS THE FOLLOWING:**

| YEAR | LOCAL/NATIONAL DISPOSAL OPTION |
|---|---|
| 1992 | BASELINE |
| 1998 | CONDITIONAL EXEMPTION |

**THIS SECTION OF THE MODEL IS IN ESSENCE TELLING THE MODEL TO USE THE *BASELINE* DISPOSAL WASTE FLOWS FROM 1992 THROUGH 1997 AND THEN USE THE *CONDITIONAL EXEMPTION* WASTE FLOWS FROM 1998 ONWARD. AGAIN, THE MODEL CANNOT ACCOMMODATE DISPOSAL FLOW OPTIONS THAT ARE NOT DEFINED IN THE LAMP DISPOSAL MANAGEMENT FLOWS SECTION.**

## 7.10 SCENARIO SPECIFICATIONS

**THIS SECTION OF THE MODEL ALLOWS YOU TO COMBINE THE VARIOUS COMPONENTS OF THE MODEL INTO A SCENARIO. ENTER THE SECTION AND YOU WILL SEE THE FOLLOWING ON THE SCREEN.**




**NOTE THAT A SCENARIO IS COMPRISED OF:**

- **A GROWTH OPTION - GROWTH OPTIONS SET THE RATE AT WHICH COMMERCIAL BUILDING SPACE IN THE UNITED STATES GROWS.**

- A Mercury Content Option - Mercury Content Options set the mercury content of lamps by type of lamp and by year.
- A Lamp Use Option - Lamp Use Options set the patterns by which the various types of lamps are used in buildings, and the rate of disposal.
- A National Disposal Option - National Disposal Options establish the waste management of lamps (*E.G.*, by lamp type, by building type, and by year), and the emissions rates of the steps in the management process.
- A Base Case - The base case establishes cases for comparing energy savings from various policy options.

Now let's build a new scenario.

## 7.11 BUILDING A SCENARIO

Scenarios are built through the Edit Data Menu. We have installed some features to ease this process, which will be discussed in this chapter. In essence there are two types of data edits that can be made. First, the Commercial Building Space and Lamp Type sections are limited to a simple line edit feature. If you wish to change the values in these screen just click on the data items you wish to change and make your changes. While all of the screens can be edited using this process, there are features on most of the others to ease the editing. To demonstrate we will create a new scenario.

Many of the analyses we anticipate users may wish to conduct involve making slight changes to a portion of a scenario. Because scenarios are data intensive, we have provided a feature to ease this process. Enter the Lamp Use Option portion of the data menu and then double click on the Edit Lamps Use Options button. Scroll down to an empty box and enter an option name and description. The name must be unique and cannot duplicate another option name. We have now established a destination for copying the records we wish to edit. Exit the screen, which should return you to the Lamp Use Option Screen.

Now click on the Create/Delete New Records Button, and then click on the Lamps Use Option bar on the left. Under Origin/Key Variable Values, click on the down arrow and select the option you wish to copy into your new option. Move to the Destination Key Variable column and click on the down arrow. The option you just named should be visible. Highlight that option. Now click on Append Records. Exit this screen and return to the Lamp Use Option Menu. You can see we added 18 records, and scrolling to the end of the records you should see your new option. You may now use the screen edit feature to place the lamp use patterns you wish to use into your new option.

Go back to the Scenario Specifications portion of the model in the Edit Data Menu. By scrolling down to the end of the form, you will see a blank scenario specification entry. Give your scenario a name (again it must be unique), a unique two character code, and select the elements you wish for your scenarios by clicking on the down arrow buttons to the right of the scenario components, *E.G.*, when selecting the Lamp Use Option you may select your new lamp use option.

**THE BASE CASE SECTION OF THE SCENARIO SPECIFICATIONS SCREEN PROVIDES A MEANS FOR COMPARING ENERGY SAVINGS AMONG SCENARIOS; *I.E.*, YOU ARE DEFINING ANOTHER SCENARIO AGAINST WHICH TO MEASURE THE INCREMENTAL ENERGY SAVINGS PROVIDED BY YOUR NEW SCENARIO. IN MAKING SELECTIONS FOR THE ENERGY BASE CASE, PLEASE NOTE THAT THE SELECTED 'BASE CASE' SHOULD HAVE THE SAME COMMERCIAL BUILDING SPACE GROWTH OPTION, BUT ALL OTHER ASPECTS OF THE SCENARIO MAY DIFFER.[1]**
**WHEN YOU ARE DONE SPECIFYING YOUR NEW SCENARIO, CLOSE OUT THE SCREEN, CLOSE OUT THE EDIT DATA MENU, AND RETURN TO THE MAIN MENU. ENTER THE SELECT SCENARIOS MENU, AND YOU SHOULD SEE YOUR NEW SCENARIO ON THE SELECTION LIST. (YOU MAY HAVE TO SCROLL DOWN TO THE END OF THE SCENARIO LIST.) IF YOU WISH TO RUN YOUR NEW SCENARIO, MOVE IT TO THE SELECTED BOX, MOVE ALL OTHER SCENARIOS TO THE SELECTION LIST, CLOSE THE SCREEN, AND RUN DATA DIAGNOSTICS. AFTER VERIFYING THAT THERE ARE NO ERRORS, EXIT THE DATA DIAGNOSTICS BY SELECTING CLOSE FROM THE 'FILE' SECTION AT THE TOP OF THE SCREEN.**

[1] If the growth rates of floorspace differ, the energy savings will be made across differing amounts of floorspace, and thus will not be a valid comparison.

# 8. CALCULATING EMISSIONS FOR SELECTED SCENARIOS

**NOW DOUBLE CLICK ON THE CALCULATE EMISSIONS FOR SELECTED SCENARIOS BUTTON. WHEN THE PROGRESS BAR SHOWS 100 PERCENT COMPLETE AND THEN DISAPPEARS, THE SCENARIO IS READY TO VIEW THROUGH THE REPORTS AND GRAPHS SECTIONS. NOTE THAT ANY TIME YOU CHANGE ANY INPUTS OR VARIABLES, YOU NEED TO RECALCULATE THE EMISSIONS. YOU HAVE NOW COMPLETED THIS INITIAL WALK-THROUGH OF THE MERCURY EMISSIONS MODEL. AS YOU GAIN EXPERIENCE IN DEVELOPING AND BUILDING SCENARIOS, THE PROCESS WILL BECOME EASIER.**